A. OVERVIEW

Sea Launch is a new, innovative system for launching commercial satellites from a platform at sea. It is being developed in response to high market demand for a more dependable and affordable commercial satellite launching service. The Sea Launch program is an international joint venture owned by Boeing Commercial Space Company, RSC Energia, KB Yuzhnoye, and Kværner Maritime a.s.

The system will utilize the proven Block DM-SL and Zenit rocket, manufactured by RSC Energia of Russia and KB Yuzhnoye of the Ukraine, to launch its satellite payloads (spacecraft) from equatorial locations in the Pacific Ocean. The rocket will be launched using two vessels: the assembly and command ship (ACS) and the launch platform (LP), which are provided by Kværner Maritime a.s of Norway. In port, the ACS will serve as the rocket assembly and integration facility and as the mission control center at the launch location. The LP is a converted, semi-submersible drilling platform. It will transport the integrated launch vehicle (ILV) to the launch location and will be used as a steady launch pad for the conduct of launch operations.

The Home Port is proposed as the staging area for Sea Launch operations. It will provide the facilities and personnel necessary to prepare for launch missions. The principal operations to be conducted in the Home Port are spacecraft processing, encapsulation and integration of the spacecraft payload, assembly and checkout of the rocket, vessel maintenance and resupply, and mission operations planning.

The proposed Home Port location for Sea Launch is in Long Beach, California, USA. Sea Launch will lease a portion of the former Long Beach Naval Station from the Port of Long Beach. The 17-acre facility is located on a narrow strip of land, known as the "Navy Mole." This location offers advantages from the perspective of security as well as offering a controlled access location for the conduct of spacecraft fueling operations. From a marine perspective, this location is adjacent to the harbor entrance, offering ready access to the deep water channel, as well as possessing a large turning basin for maneuvering the vessels. Refer to Figure A-1.

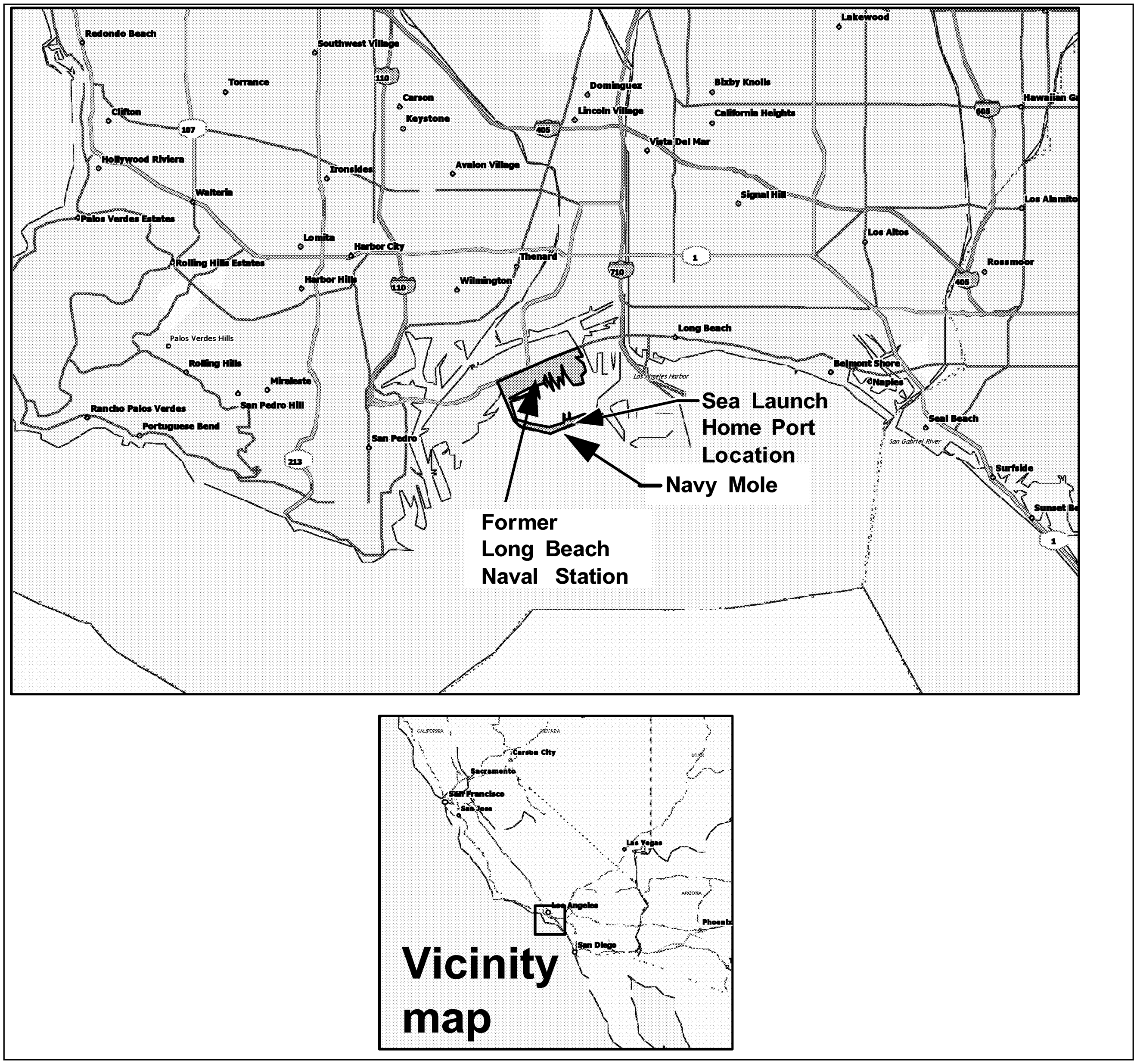

Figure A-1. Home Port Location and Vicinity

The integrated rocket and spacecraft to be launched by Sea Launch will be processed in the Home Port according to the following generalized scenario. The processing flow diagram is shown in Figure A-2.

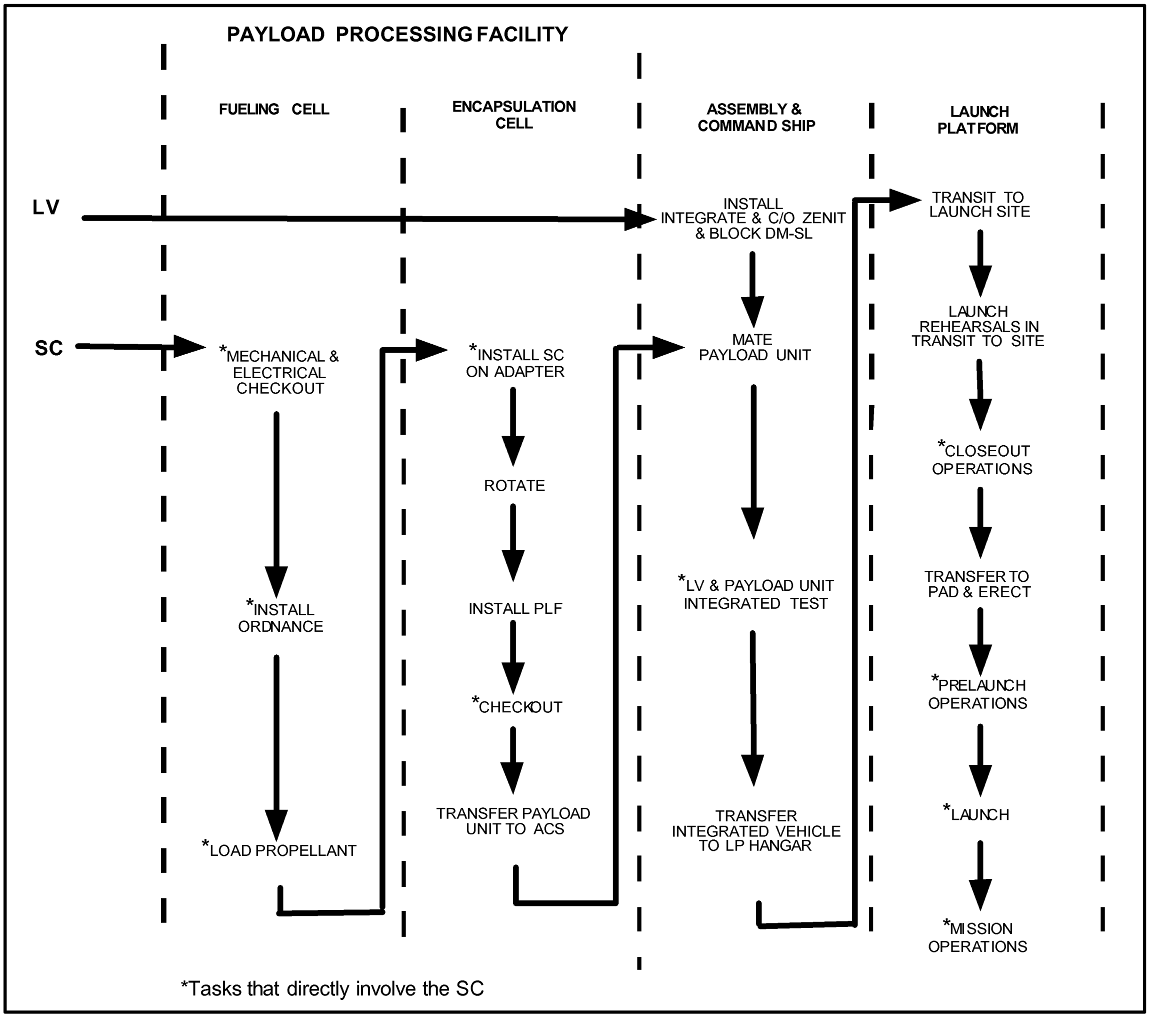

Figure A-2. Spacecraft Processing Flow

1. The spacecraft and its ground support equipment (GSE) will be delivered to the payload processing facility (PPF) by the customer (spacecraft manufacturer). The spacecraft will then be moved to its processing cell and the GSE is set up in the adjacent control room. Processing of the spacecraft will be the final phase of the assembly sequence. Processing will consist of electrical, mechanical and pneumatic functional checks, ordnance installation, and propellant loading.

2. After propellant loading operations are complete, functional tests will be run, the spacecraft will be installed on its adapter, rotated into the horizontal position, encapsulated in the fairing (which has been stored in an on-site warehouse), and tested as required. When encapsulation is complete, the encapsulated payload is considered ready for transfer to the ACS.

3. Individual, inert rocket stages, which are delivered via commercial ships, will be stored at the Home Port. Small solid rocket motors (SRMs), which are used to separate the rocket stages in flight, will be stored separately until they are loaded on the ACS with the rocket stages. Parallel to spacecraft processing, the three inert stages of the rocket will be transferred from the warehouse to the ACS where they will be processed and mated together. During the processing, the upper stage (Block DM-SL) will be partially fueled prior to mating to the second stage. Once

the rocket processing, assembly and checkout have been completed on the ACS, the encapsulated payload will be transferred to the ACS for integration with the rocket.

4. On the ACS, the encapsulated payload will be mated to the rocket and the interfaces checked out and verified. When the launch vehicle checks are complete, the ACS and LP will be positioned end to end and the integrated rocket will be transferred from the ACS to the LP. Prior to leaving the Home Port, rocket fuel components and compressed gasses will be delivered and transferred onto the LP. (Note: Fueling of the rocket occurs at the launch location just prior to launch.)
5. Both vessels will depart the Home Port at the same time for the equatorial launch region and conduct of launch operations.
6. After launch, the vessels will return to the Home Port. In preparation for the next user, the spacecraft GSE will be removed from the processing facilities, ACS, and LP.

The Home Port facilities will consist of an office building, a payload processing facility, warehouse buildings, and the pier. Each of these areas is described briefly below, and in more detail in Section A.4.

1. The office building is a two-story structure of approximately 2,230 m^2 which currently exists on the location. It contains offices, conference rooms, and a marketing, training, and break area. This will serve as the Home Port management and engineering area in addition to customer offices.
2. The PPF will be a new building constructed approximately 94.5 m east of the existing buildings in the Home Port complex. The building will be approximately 3,000 m^2 with a high bay height of 19.8 m for the encapsulation cell. This facility will be used for spacecraft processing and short-term (less than 30 days) storage of spacecraft propellants. This facility will consist of two processing cells, an encapsulation cell, control rooms, change rooms, fuel cart storage areas, and a central air lock. All spacecraft processing areas will be constructed to Federal Standard 209 Class 100,000 cleanliness standards.
3. The warehouse facilities consist of existing buildings which are located near the office complex, with a total area of approximately 9,290 m^2. The large warehouse building (building 4, Figure A.4-1) will be used for storing inert rocket stages, fairings, and adapters. The remainder of the buildings will be used for storage of spares and consumables necessary for Home Port operations, spacecraft customer spares, and shipping containers. Modifications (e.g., installing doors and shelving) and cosmetic maintenance will be required.
4. The pier is an existing structure adjacent to the other facilities. It is a concrete structure supported by wooden pilings and is capable of supporting any loads which can be transported over highways. It is approximately 335 m by 18.3 m and is accessible from both sides for moorage of the vessels. Water depth at the pier is 10.7 m to 11.6 m, which is capable of supporting SLLP vessels. The pier is equipped with facilities for electrical power, water, sewage, and moorage fittings. Minor modifications to the waterfront adjacent to the pier will be required to provide a ramp landing capable of roll-on/roll-off loading of inert rocket stages and encapsulated payloads to the ACS.

A.1 LAUNCH VEHICLE DESCRIPTION

A.1.1 Vehicle History

The Zenit-3SL is a liquid propellant, launch vehicle system capable of transporting spacecraft to a variety of orbits. Figure A.1.1-1 shows the Zenit-3SL principal components.

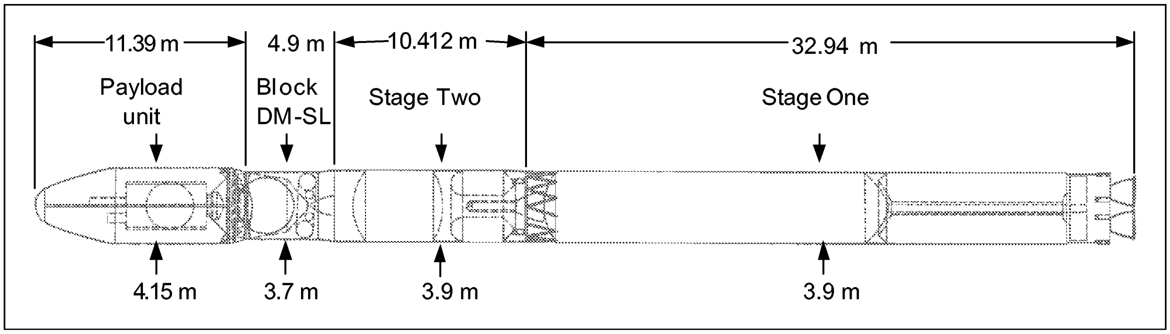

Figure A.1.1-1. Zenit-3SL Launch Vehicle

The first two stages of the Zenit-3SL are manufactured by KB Yuzhnoye in the Ukraine. The basic two-stage Zenit was developed to provide a means of quickly reconstituting military satellite constellations with design emphasis on robustness, ease of operation, and fast reaction times. The result is a highly automated launch system requiring only a small launch crew. First flown in 1985 from the Baikonur Cosmodrome in Kazakhstan, the Zenit's original use was as a launcher for electronic intelligence satellites. As of 1998, the Zenit has completed 26 missions in 31 launch attempts. Additionally, Stage 1 of the Zenit is virtually identical to the strap-on boosters used with the RSC Energia heavy lift launch vehicle. Four strap-ons are used for each Energia launch.

The Block DM-SL constitutes the upper stage of the Zenit-3SL. The Block DM is built by RSC Energia in Russia, and has had a long and successful history as the fourth stage of the Proton launch vehicle. The Block D upper stage model series has completed 196 missions in 204 launch attempts. The Block DM model used by Sea Launch has completed 98 missions in 103 launch attempts.

A.1.2 Zenit Stage 1

The Stage 1 principal structure is aluminum with integrally machined stiffeners. The RD-171 engine that powers Stage 1 burns liquid oxygen (LOX) and kerosene (RP-1). The LOX tank is positioned above the kerosene tank, and the lower dome of the LOX tank is located in the concave top of the kerosene tank. A single turbopump feeds four thrust chambers, and four differentially-gimbaled thrust nozzles provide directional control during Stage 1 powered flight. Stage 1/Stage 2 separation is accomplished through the use of forward firing solid propellant thrusters located in the aft end of the first stage.

A.1.3 Zenit Stage 2

The second stage of the Zenit also employs integrally stiffened aluminum construction. Stage 2 propellants are LOX and kerosene, and the lower kerosene tank is toroid shaped and the LOX tank is a domed cylinder. This stage is powered by a single nozzle RD-120 engine.

Three-axis control is provided by a RD-8 vernier engine which is mounted in the aft end of Stage 2. The RD-8 uses the same propellants as the RD-120, with one turbopump feeding four gimballing thrusters. The RD-8 produces 8100 kg of thrust. Stage 2/Block DM-SL separation is accomplished through the use of forward firing solid propellant thrusters located near the aft end of the second stage. Stage 1 and Stage 2 of the Zenit configuration are shown in Figure A.1.3-1.

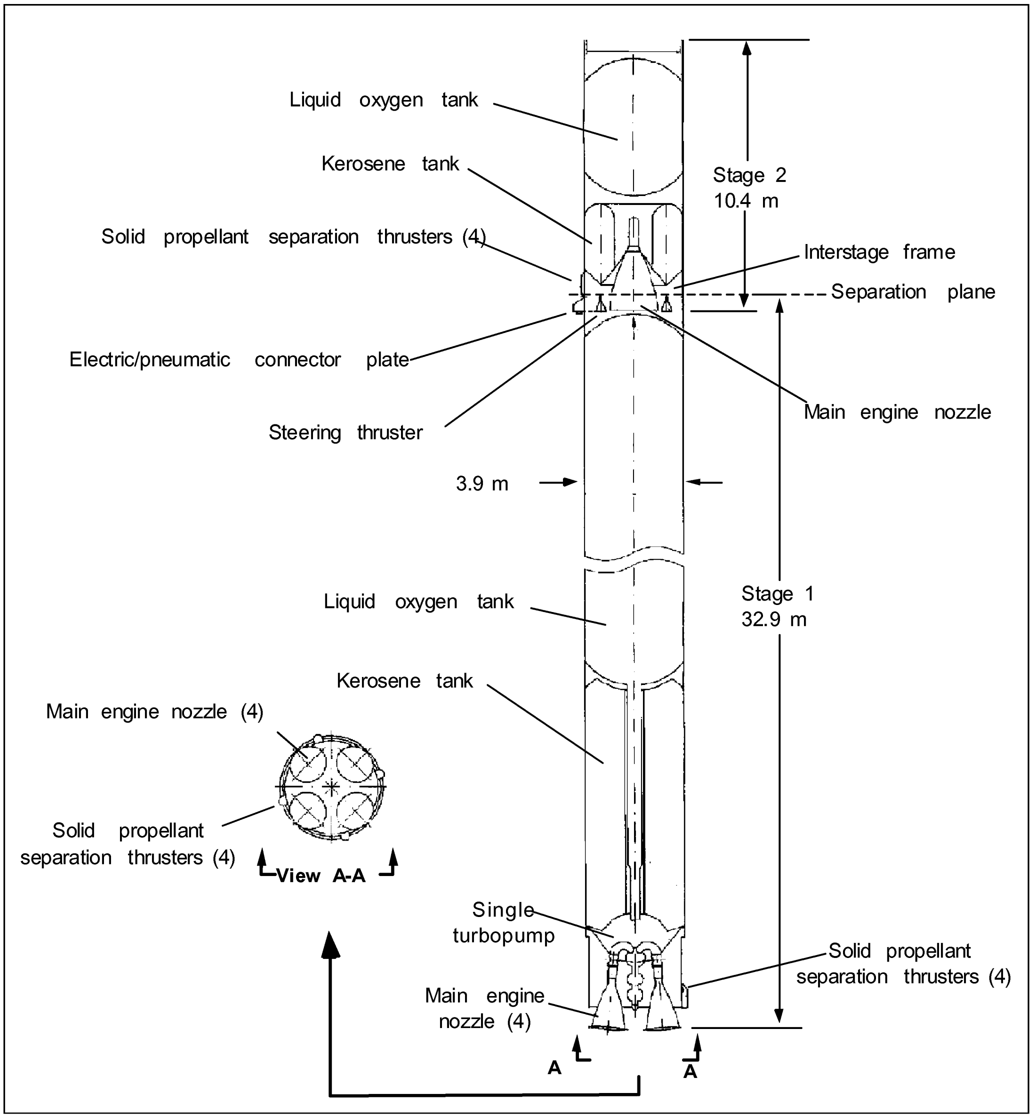

Figure A.1.3-1. Zenit Stage 1 and Stage 2 Configuration

A.1.4 Block DM-SL - Upper Stage

The Sea Launch Block DM-SL (Figure A.1.4-1) is a restartable upper stage which is capable of restarting up to seven times during a mission. The Block DM-SL is enclosed in an interstage cylinder of aluminum skin and stringer construction. All but the upper section of the interstage is jettisoned prior to the first firing of the Block DM-SL main engine. Avionics are housed in a toroidal equipment bay at the front end of the Block DM-SL.

Propulsive capability for the upper stage is provided by the 11D58M engine which operates on LOX and kerosene. The kerosene is contained in a toroidal tank which encircles the main engine turbopump. The spherical LOX tank is located above the kerosene tank. The 11D58M has a single gimballing nozzle which provides directional control during propulsive phases.

Three-axis stabilization of the Block DM-SL during coast periods is provided by two attitude control/ullage engines. Each engine has five nozzles that are grouped in clusters on either side of the main engine nozzle. The attitude control system uses the hypergolic propellants nitrogen tetroxide (N_2O_4) and monomethylhydrazine (MMH).

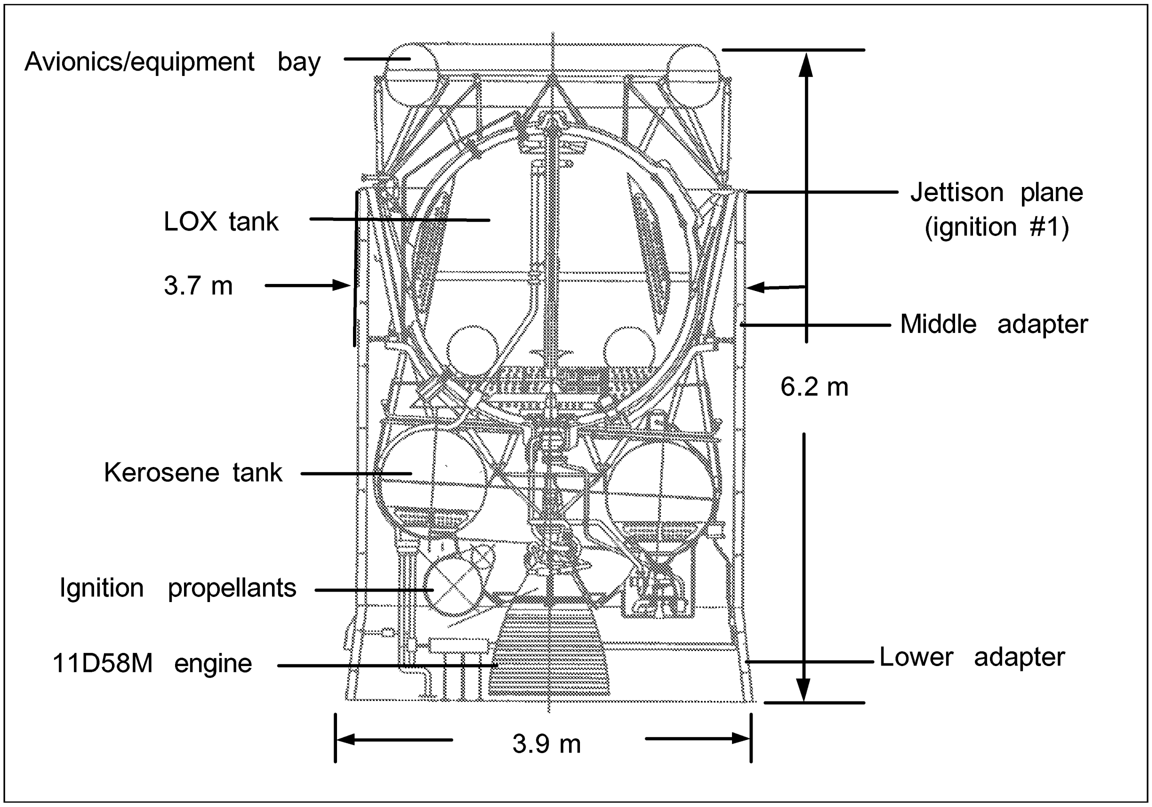

Figure A.1.4-1. Block DM-SL

A.1.5 Payload Unit

The payload unit (PU) consists of the spacecraft, adapter with spacecraft separation system, interface skirt, payload fairing (PLF), and the flight instrumentation package. The PLF, payload adapter (PLA), interface skirt, and spacecraft form a single, transportable item during ground processing (fig. A.1.5-1). These elements are brought together at the payload processing facility (PPF) in the Home Port and are integrated with the launch vehicle as a package onboard the ACS. The PU interface skirt mates to the interfacing ring of the Block DM-SL and encloses its toroidal equipment bay. The PU is 11.39 m long, as measured from the tip of the nose cap to the interface skirt/upper stage interface. The PU has an internal diameter of 3.9 m and an external diameter of 4.15 m.

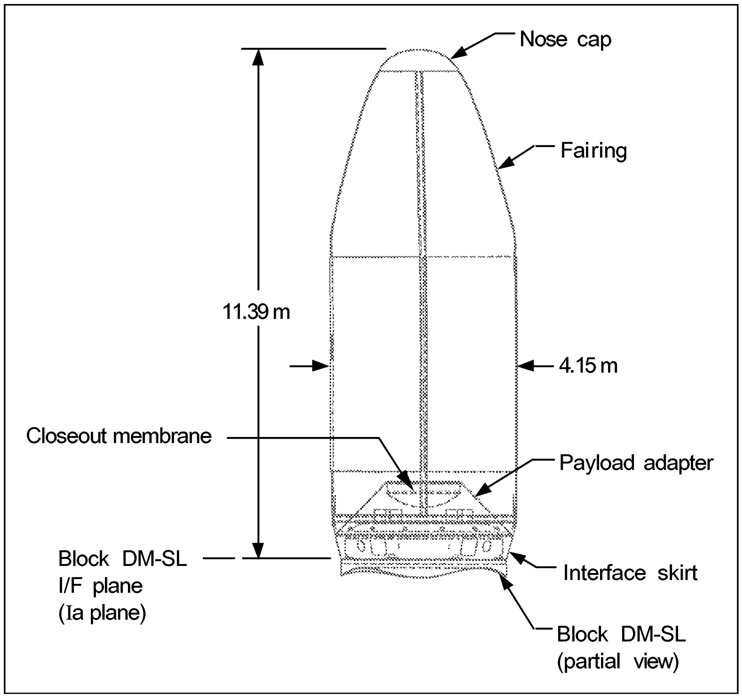

Figure A.1.5-1. Zenit-3SL Payload Unit

A.1.5.1 Payload Fairings

Sea Launch PLFs provide environmental protection for the spacecraft from the time of encapsulation through launch and ascent and can accommodate a wide range of payloads.

The PLF is 10.58 m long and is constructed in two sections of graphite composite external and internal skins. The PLF has a honeycomb core with a metallic nose cap device.

Prior to roll out to the launch pad, access to the spacecraft is gained through the access hatches in the payload fairing. The baseline design includes two PLF access hatches, approximately 0.61 m in diameter, located on opposite sides of the PLF longitudinal separation plane and at least 17^0 from the separation plane. Within PLF structural constraints, variations in the number, location, and size of the hatches can be accumulated.

Prior to launch, conditioned air is provided to the payload fairing volume. The cooling air flows from the forward end of the PLF to the aft end where it exits through one-way valves on the payload structure.

External thermal insulation protects the PLF structure and limits the interior PLF surfaces from reaching temperatures above 65^0C during ascent. The PLF is jettisoned at a time sufficient to ensure that the spacecraft's dispersed maximum free molecular heating (FMH) never exceeds 1,135 W/m^2. The time of PLF jettison (and associated maximum FMH) can be tailored by the customer.

A.1.5.2 Interface Skirt/Payload Structure

The interface skirt/payload structure, which joins the PLF and adapter to the upper stage, is constructed of aluminum with integral stiffeners. The interface skirt portion is 0.81 m long and accommodates the transition from a 3.715 m diameter on the Block DM-SL to a 4.15 m diameter on the PLF. The payload structure portion provides the structural tie between the spacecraft adapter and the interface skirt portion. The interface skirt/payload structure assembly includes an encapsulation membrane and acts as a contamination barrier between the PU and the Block DM-SL. One-way valves in the adapter structure permit airflow out of the PLF while maintaining positive differential air flow (or pressure differential) in the PLF during all operations.

A.1.5.3 Adapters

The spacecraft adapter, payload structure, and the interface skirt serve as the interface between the spacecraft and the launch vehicle. They physically support the spacecraft in a horizontal attitude for integration with the launch vehicle, during transportation to the launch location, and in a vertical attitude while on the launch pad.

The adapter mechanical interface to the spacecraft is either a bolted or a Marmon clamp design. Spacecraft separation from the adapter is accomplished with separation ordnance or through the release of this clamp.

A.2 MARINE SYSTEMS

The marine segment of the Sea Launch system includes the ACS and the LP, which together will support the integration of the launch vehicle, transportation to the launch location, and launch.

A.2.1 Assembly and Command Ship

The ACS will perform four functions for Sea Launch operations:

1. It will serve as the facility for assembly, processing, and checkout of the launch vehicle.
2. It will house the mission control center, which monitors and controls all operations at the launch location.
3. It will act as the base for tracking the initial ascent of the launch vehicle.
4. It will provide accommodations for the marine and launch crews during transit to and from the launch location.

A first aid clinic will be provided on both the ACS and LP with capability of functioning as a casualty support location in the event of a serious accident.

The ACS (Figure A.2.1-1) is designed and constructed specifically to suit the unique requirements of Sea Launch operations. The basic structure of the ACS is based on a Roll-On/Roll-Off (Ro-Ro) cargo vessel. The ship has an overall length of approximately 200 m and a beam of 32.26 m. Its overall displacement is approximately 30,830 metric tonnes.

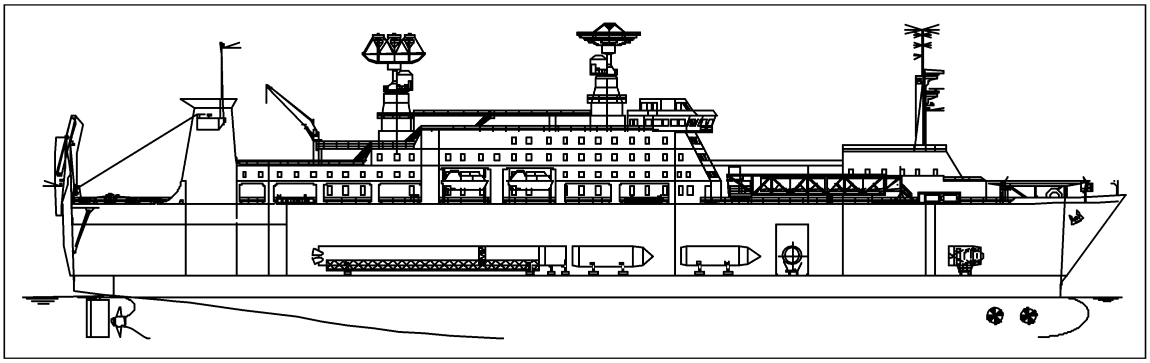

Figure A.2.1-1. Assembly & Command Ship

A.2.2 Launch Vehicle Integration Area

Launch vehicle stages will be loaded onboard the ACS in the Home Port through the stern ramp (Figure A.2.2-1). Processing and assembly of the stages will be conducted on the rail systems in the rocket assembly compartment on the main deck, accommodating parallel processing of up to three launch vehicles at one time. A special area in the bow of the main deck will be dedicated for processing and fueling of the Block DM-SL upper stage. Processing and assembly of the launch vehicle will typically done in port in parallel with spacecraft processing operations, but many of these operations may also be accomplished during transit to and from the launch location.

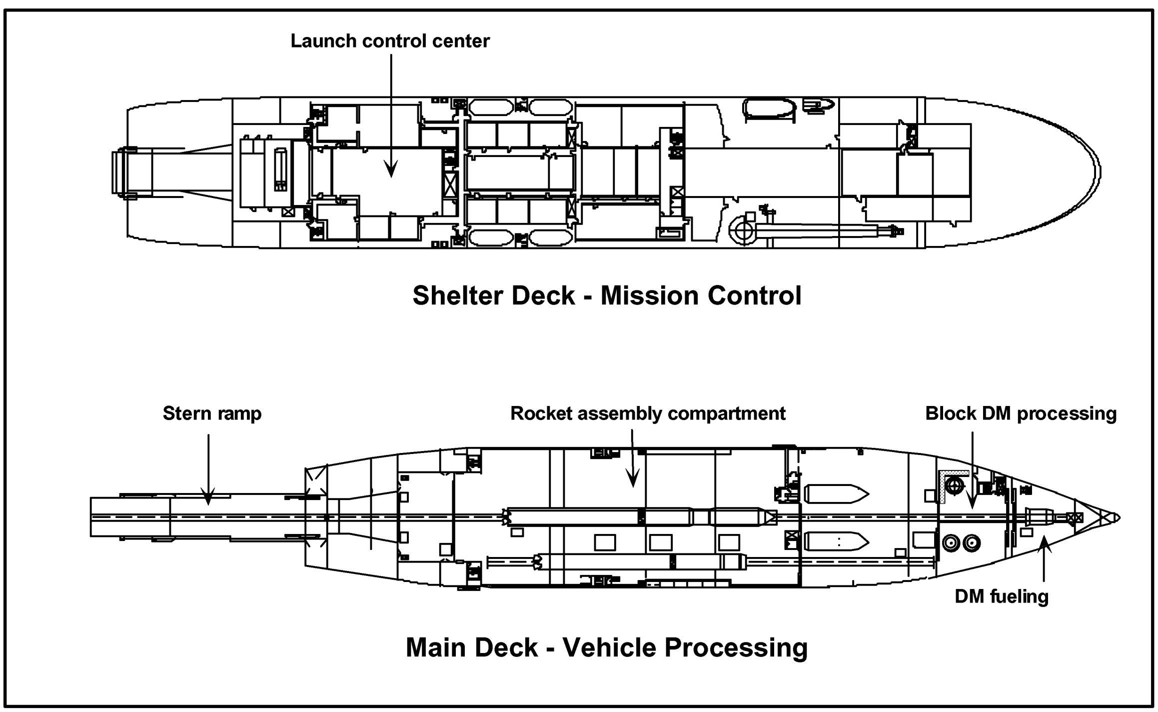

Figure A.2.2-1. Launch Vehicle Processing and Mission Control

A.2.2.1 Block DM-SL Fueling Process

Fueling of the upper stage will be accomplished onboard the ACS prior to mating with the first and second stages. This operation will be accomplished with the ship moored parallel to the pier which will also allow for easy personnel access. Normal ship evaluations and some limited launch support operations will continue during the upper stage fueling operation. The systems supporting this operation will be installed in four compartments located below the shelter deck between frames 221 and 189 (Figure A.2.2-1).

The upper stage fueling compartment (DM fueling) will be located on the main deck between frames 221 and 203. An air lock is provided directly aft of this compartment (frames 203 to 201) to isolate this space from the adjacent assembly areas. Access to the DM fueling compartment will be provided by a large set of sliding doors in the bulkheads at frames 203 and 201 to allow movement of the upper stage through the air lock. These doors will be provided with gas tight seals to maintain the air lock seal. A personnel access door will be provided through the air lock bulkhead on the port side, outboard of the lift/stairwell. This door will also be provided with gas tight seals. The air lock will cover the complete bulkhead between the main deck and the shelter deck. Stuffing tubes and related seals will be provided for all penetrations through the air lock bulkheads. The DM fueling compartment will contain facilities to connect the fuel transfer lines to the upper stage fuel fitting.

Fuel equipment compartments will be provided between the tank top and the main deck between frames 213 and 189. The two compartments directly under the main deck (tween deck) will contain the fuel service system for the two hypergolic components: MMH and N_2O_4. The two compartments will provide complete separation of the fueling components. A change room will be located forward of each compartment, which will also serve as an air lock between the fuel equipment compartments and the companion way/stair well.

A separate ventilation system, designed to control the potential accidental release of toxic and explosive vapors during fueling operations, will be provided. The supply and exhaust ventilation systems will be balanced to maintain a lower atmospheric pressure in the hazardous areas. The design of a means of scrubbing hazardous vapors from the exhaust air will be developed to achieve zero release of MMH or N_2O_4. The exhaust from this system will be located near the top of the forward mast, approximately 13 m above the weather deck. This location will also provide additional dilution if any release were to escape.

A.2.2.2 Rocket Assembly Process

Assembly of the integrated launch vehicle includes assembly of the Zenit Stages 1 and 2 and their mating, mating of the Block DM-SL upper stage to the second stage of the Zenit, and mating of the payload unit to the Block DM-SL upper stage.

The Zenit stages will be prepared for assembly by removing protective covers and fixtures used for transportation/shipping and positioned on the center rail in the rocket assembly compartment (Figure A.2.2-1). The first and second stages will be properly aligned and mechanically mated; electrical and piping connections will then be mated and verified. The onboard control system will be tested through the use of a computer-controlled test system. The test software will be verified in the factory prior to use onboard the ACS. Electrical test equipment will use unique connectors to preclude improper connections. Pneumatic test equipment connections will also be of unique configurations. The propellant tanks and piping (liquid oxygen: 1.8 kgf/cm^2) and kerosene tanks (1st stage - 1.6 kgf/cm^2 and 2nd stage 1.5 kgf/cm^2) will be leak tested. The pressurant system's nitrogen and helium tanks are charged to 220 (+10/-5) kgf/cm^2 and the propellant control and flow systems are leak tested at 15 kgf/cm^2. The four retro rockets (stage separation SRMs) will be installed on each stage. The Block DM-SL upper stage will be mated to the assembled Zenit stages and electrical interface connectors will be verified.

The encapsulated payload will be loaded onto the ACS from land through the stern ramp. Once onboard, the encapsulated payload and its transportation dolly will be positioned on the center rail in the rocket assembly compartment for integration with the launch vehicle. The payload unit will be mated to the Block DM-SL and interface electrical connections will be verified.

After the payload is integrated with the launch vehicle and all checkouts are complete, the integrated launch vehicle will be transferred to the launch platform. Environmental conditioning and monitoring of the encapsulated spacecraft is continuous from spacecraft encapsulation through launch. The only breaks are during transfer from stationary to mobile environmental conditioning units (less than three minites). Monitoring equipment will be mounted near the conditioned air exhaust from the spacecraft and upper stage.

A.2.2.3 Integrated Launch Vehicle Transfer from ACS to LP

Transfer of the ILV from the ACS assembly area to the LP hangar will be accomplished just prior to the LP departing the Home Port for the launch area. At this time, all other operations related to provisioning the LP and preparation of the ILV will have been completed. The following general sequence of operations will be accomplished to achieve the safe transfer:

1. The ACS will be moved from its portside berth and moored by its starboard side forward of the LP so both the ACS and LP centerlines are in a common straight line. The launch platform lies close to the pier, while the ACS has to be moored at some distance from the pier in order to be in centerline with the LP (Figure A.2.2-2).
2. The stern ramp will be lowered in horizontal position and a support cable system is attached between the end of the ramp and the LP. This support cable transfers some load from the ACS to the LP during the operation as well as supporting the stern ramp (Figure A.2.2-3).
3. Door and deck hatches in the front of the LP hangar will be opened and secured in the open position. The two LP hangar cranes will be moved into position to lift the ILV. Four guide cables will be installed (two on each side) between the ramp and the LP crane bridge. The guide cables will be kept taut by a tensioning system and will be used to guide and stabilize the ILV during hoisting.
4. The ILV and carriage will be moved out onto the ramp and positioned for lift. The ILV lifting equipment will be mounted on the rocket and prepared for connection to the LP crane hooks. The carriage prelift hydraulic system cylinders will now prepared to lift the ILV from the carriage.
5. The ILV lifting equipment includes transverse bars that will be attached to the crane hook. The ends will be equipped with rollers that attach to the guide cables and also to the hydraulic prelifting system. The transverse bars will be prepared for connection to the lifting crane hooks.
6. Both crane hooks will be lowered and connected to the lifting bars. Slack will be taken out of the crane lifting cables but no tension is applied at this time.
7. Hydraulic power will be applied to the prelifting cylinders and the ILV is lifted clear of the carriage to a predetermined height. Slack will be taken out of the crane lifting cables but no tension will be applied at this time.
8. Final checks for the lift operations will be accomplished. These include weather, the mooring arrangement, personnel on station, and ensuring that no other vessels are in positions which can lead to disturbances.

9. The ILV load will be transferred to the crane by lowering the prelifting cylinders.
10. The ILV will then hoisted by the cranes, which operate simultaneously to keep the rocket in a horizontal position, up to the level required to move it into the hangar. Once the ILV is at this level, the lifting bars will be released from the guiding rollers and the guide wires.
11. The ILV will then moved into the hangar position to be landed on the erector carriage.
12. The erector wagon will be moved into position under the ILV and the load will be lowered on to the erector carriage.
13. The ILV lifting equipment will be moved back to the carriage on the ACS stern ramp and the carriage will be moved into the assembly area.
14. The stern ramp will be released from the LP and both vessels will be readied for departure.

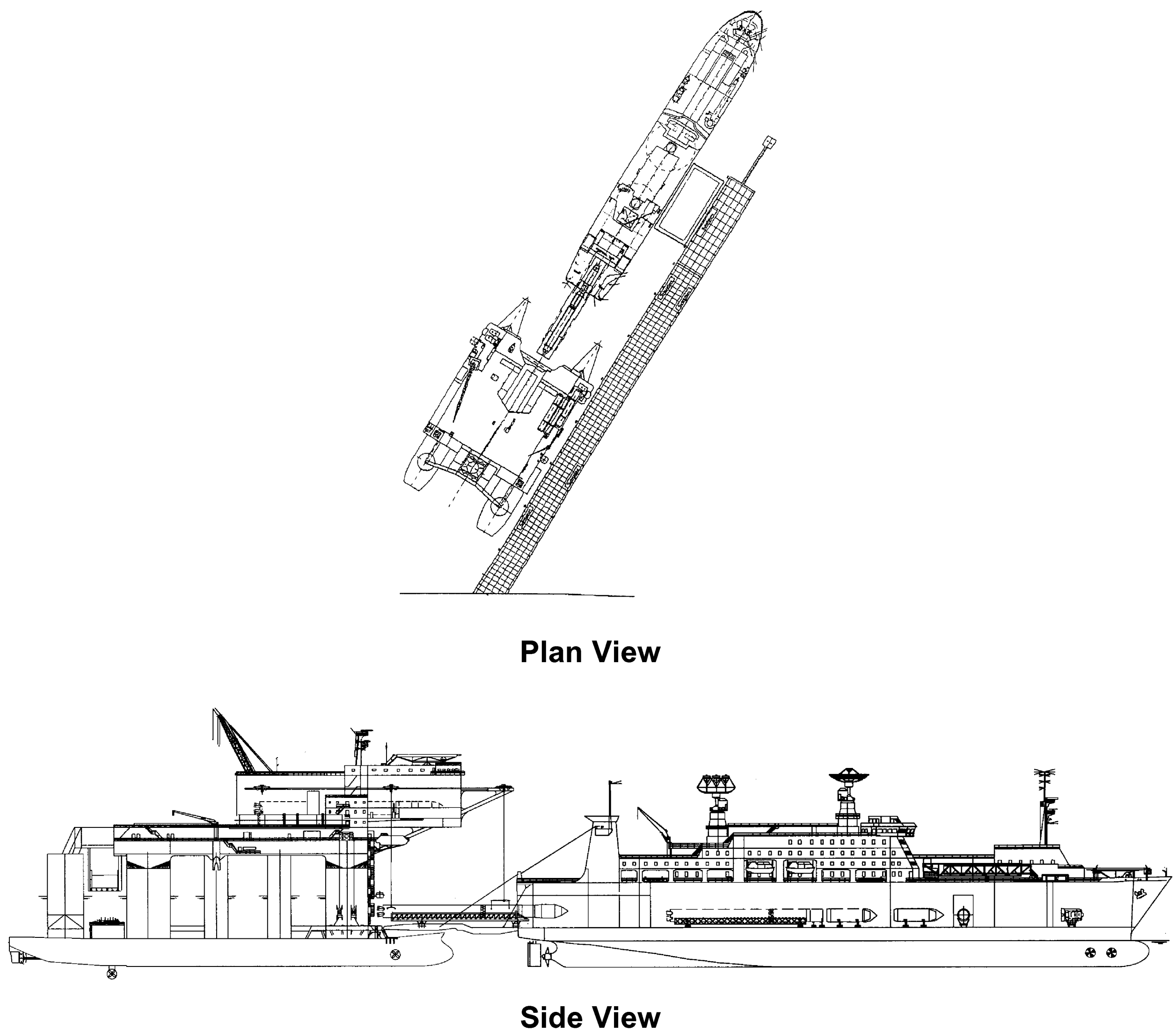

Figure A.2.2-2. ACS and LP Mooring Arrangement During Integrated Launch Vehicle Transfer

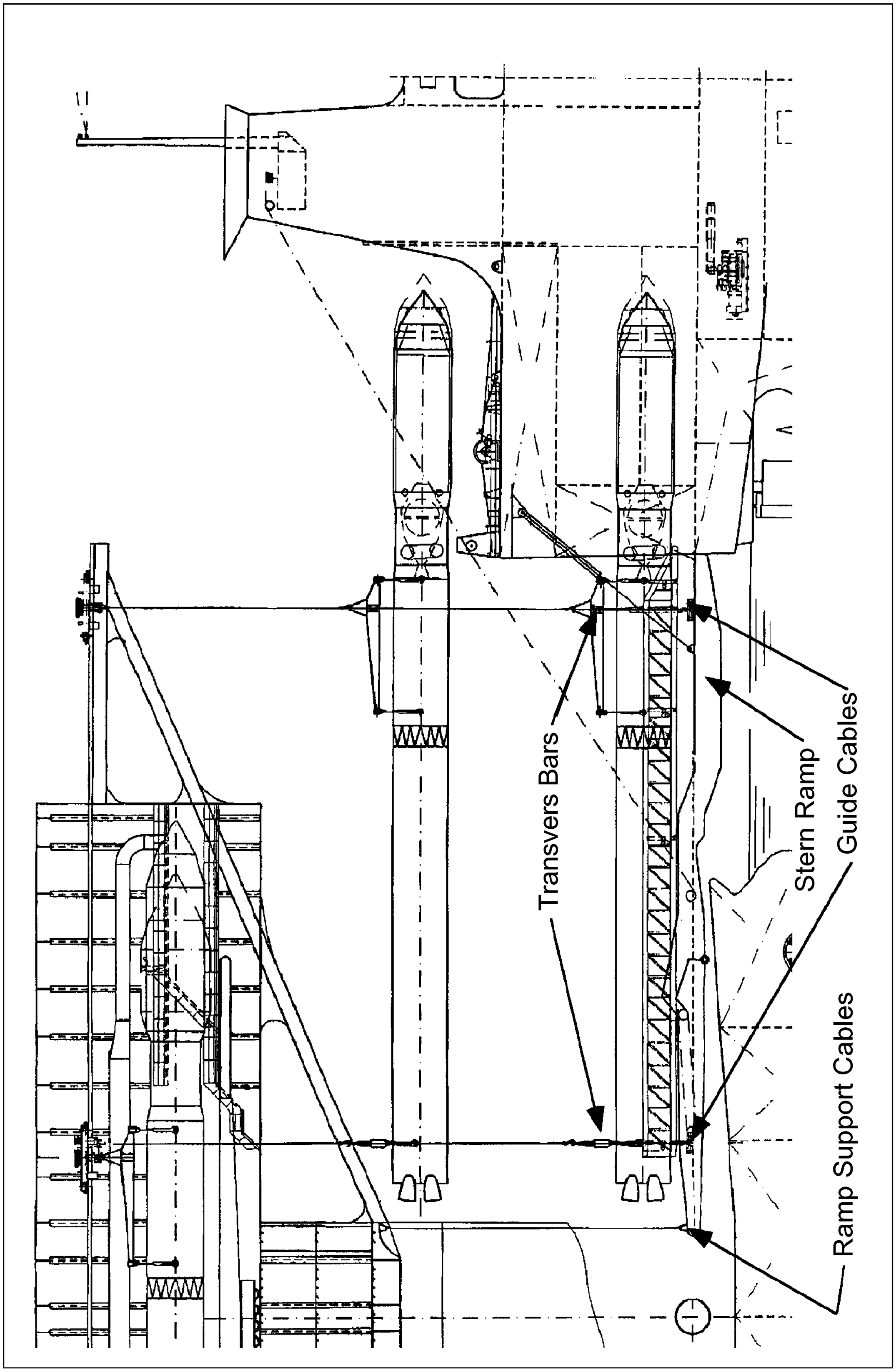

Figure A.2.2-3. Integrated Launch Vehicle Transfer Arrangement (1 of 2)

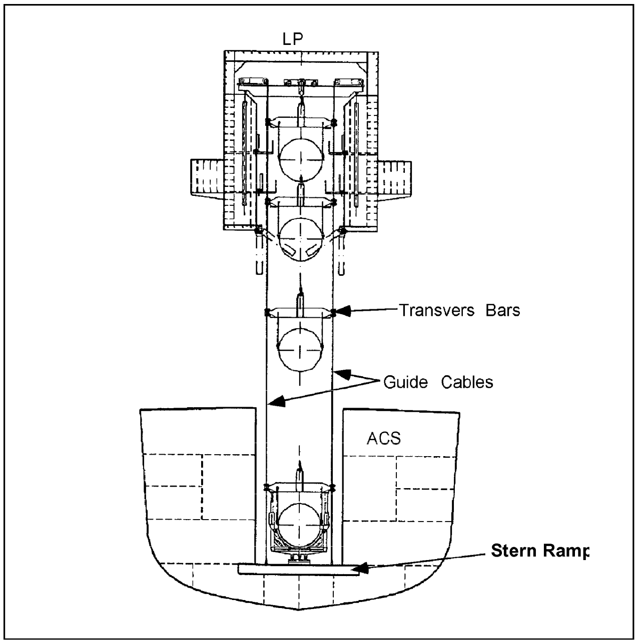

Figure A.2.2-3. Integrated Launch Vehicle Transfer Arrangement (2 of 2)

A.2.3 Launch Platform

The LP will serve as the transport vessel for the integrated launch vehicle and also serve as the launch pad. It will also provide accommodations for the marine and prelaunch crews during transit to and from the launch location. It will have all the necessary systems for launch vehicle erection, fueling, and for the conduct of launch operations.

The LP (Figure A.2.3-1) is a modification of an existing semi-submersible oil platform. This platform was designed for continuous operations in the extreme environment of the North Sea. In the relatively benign environment at the Sea Launch locations, this design will provide an extremely stable platform from which to conduct launch operations. The LP will be self-propelled by diesel-electric motors and will ride catamaran style on a pair of large pontoons. Once at the launch location, the pontoons will be submerged by ballasting to achieve the stable launch position, level to within approximately one degree. The LP will have an overall length (at the pontoons) of approximately 133 m and the launch deck will be 78 m by 66.8 m. Its overall transit displacement will be approximately 27,400 metric tonnes. Once transferred to the LP in the Home Port, the integrated launch vehicle will ride to the launch location in the enclosed hangar on the main deck. After LP ballasting at the launch location, the rocket will be rolled out to the launch pad and erected in preparation for launch.

After the launch vehicle has been erected and all launch system checks are complete, the crew members will be transferred to the ACS. Vessel station keeping and launch operations will be conducted from the ACS via redundant RF links.

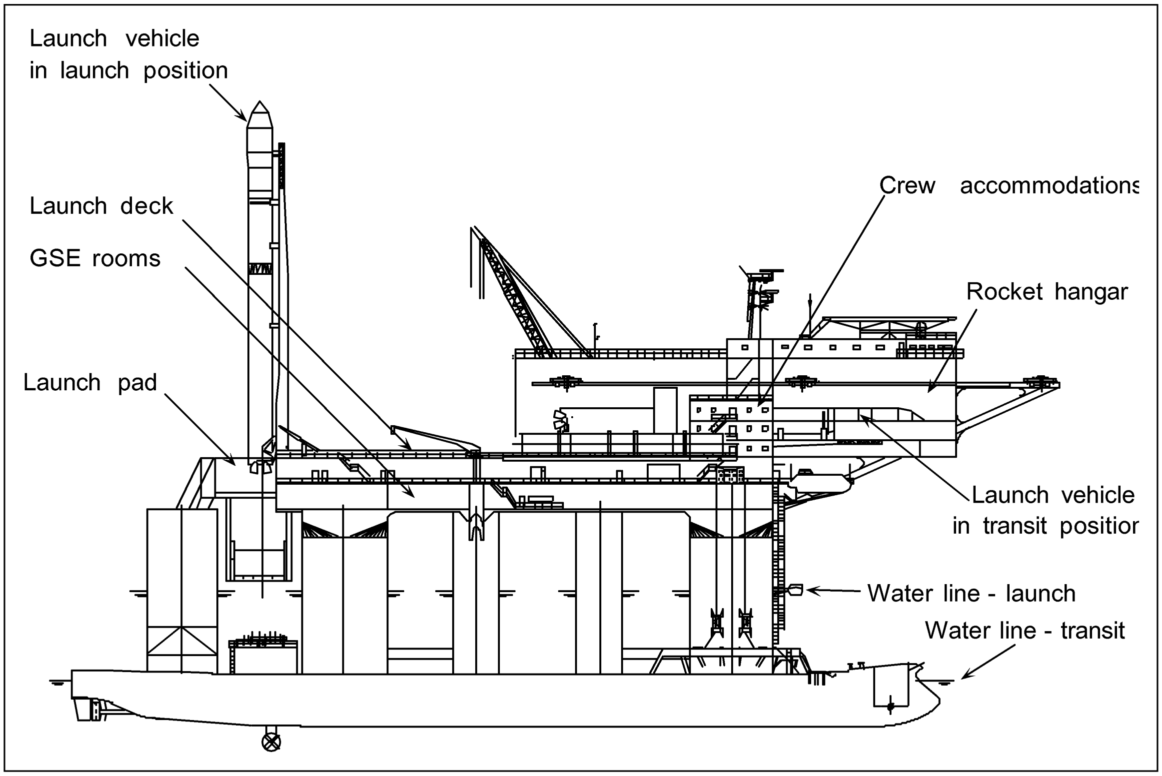

Figure A.2.3-1. Launch Platform

A.2.4 Transit Operations

The integrated launch vehicle, including the encapsulated payload, will be supported on the transporter/erector in the LP hangar during transit to the launch location. Accommodations for six customer technicians will be provided onboard the LP during transit.

While the ACS and LP are in route to the launch location, a mission rehearsal will be conducted. The rehearsal involves the launch personnel and customer personnel onboard the ACS, the tracking assets (Selena-M tracking ship, Altair satellite [sometimes called Luch satellite], ground stations, etc.), and the customer's spacecraft control center. The rehearsal will simulate the prelaunch operations and post launch operations up through spacecraft separation and completion of the Block DM-SL's contamination and collision avoidance maneuver (CCAM). The launch vehicle operations on the LP will be simulated while the launch vehicle remains in the hangar. Successful completion of the launch rehearsal is a prerequisite to launch. These operations are simulated to a major extent and systems that could pose a threat to the environment are not exercised.

Transit of the two vessels between the Home Port and the launch area will be a normal maritime operation and is controlled by existing regulations as noted in Section 3 and in Appendix B.

A.2.5 Platform Launch Operations

At the launch location, the LP will be lowered from the transit draft to the launch draft, and the ACS and LP will moor alongside each other. The launch draft provides a more stable platform. The launch may be accomplished in mean significant wave heights up to 2.5 m. This launch position will be accomplished at least 17 hrs before scheduled launch time (T). A connecting bridge will be extended between the two vessels to allow prelaunch processing personnel access to the LP. Final spacecraft "hands-on" operations (i.e., ordnance arming) will be accomplished and payload fairing hatches will be closed out. (Ordnance is used for stage separation and launch; please see Appendix B-20 for further information.) Launch management personnel and the customer will be polled and approval will be given to roll out the integrated launch vehicle (ILV) from the hangar to the launch pad.

The hangar hatches will be opened and the automatic sequence that moves the Zenit-3SL to the launch pad will be initiated. As the launch vehicle moves to the pad, the electrical, pneumatic, hydraulic, and propellant lines will be automatically connected. At the launch pad the launch vehicle will be rotated to a vertical position. Prior to rotation, the portable conditioned air supply will be switched to the launch pad conditioned air supply system.

At this time, the majority of the LP and launch support personnel will leave the LP and the ACS maneuvers to a position approximately five km from the LP. The repositioning of the ACS will occur at approximately T-15 hrs.

The transfer and verification of launch systems control and LP systems control will be started. Initial purging and conditioning of launch vehicle fueling systems will be started and final preparations accomplished. When the transfer of control and the prelaunch checkouts are completed and the results have been verified, the remaining LP and launch support personnel will be transferred by motor launch to the ACS prior to rocket fueling. The LP will now be uninhabited and all critical systems will be controlled remotely from the ACS. The transfer of the remaining personnel to the ACS will occur between approximately T-5 hrs and T-3 hrs.

The fueling of the Zenit (LOX and kerosene) and LOX loading of the Block DM-SL will be started at approximately T-2.5 hrs and completed at T-24 min. The erector will be lowered to the horizontal position and moved into the hangar and the hatch doors will be closed. Fuel lines will be drained and purged with GN_2 prior to disconnecting.

Final launch sequence will be accomplished. In order to minimize exhaust effects on the LP and acoustic effects on the spacecraft, a freshwater deluge system will be used in the flame deflector. The water deluge to the flame trench/deflector will begin at T-5 sec. Stage 1 ignition will occur at T-3 sec. The main command to ramp up the main engines to launch thrust will be issued at T=0 after engine parameters have been verified by the onboard control system.

The Zenit-3SL will be held in place on the launch table by hold-down clamps at the base of the first stage. These clamps will be released after the computers confirm that the Stage 1 engine is operating properly and engine ramp up exceed 50% thrust.

If the engine parameter verification or the hold-down clamps release is not successful, the engine will be shut down by the onboard control system prior to lift off.

A.3 ABORT OPERATIONS

Launch abort operations are described in Section 5.2 as part of the environmental analysis, and they are further addressed as a part of mission definition in the license application submitted to AST (SLLP). In general, a launch abort is a controlled event in which the rocket would be stabilized and fuels extracted and stored for reuse. The launch vehicle would then be lowered to a horizontal position and moved into the hanger on the LP. The situation would then be assessed before a decision can be made to restart the launch sequence or return to the Home Port.

A.4 HOME PORT FACILITIES AND SERVICES

The Sea Launch Home Port complex will provide the facilities, equipment, supplies, personnel, and procedures necessary to receive, transport, process, test, and integrate the spacecraft and its associated support equipment with the launch system. It also will serve as the home base for launch operations with facilities to support and service the Sea Launch vessels, including office and storage facilities. There will be no provision to support major ship repair. This work will be accomplished at a commercial facility.

The proposed Home Port is located in southern California in the Port of Long Beach. This site is part of the former Long Beach Naval Station located on the southern side of Terminal Island within the Long Beach harbor district. The proposed Home Port is located at the east end of the "Navy Mole" (Figure A.4-1), which is a large breakwater forming the western and southern boundaries of Long Beach Harbor. Access to the site is via I-110 or I-710 off the San Diego freeway (I-405). Long Beach airport (21 km), Los Angeles airport (40 km), and Orange County airport (38 km) are all within close proximity.

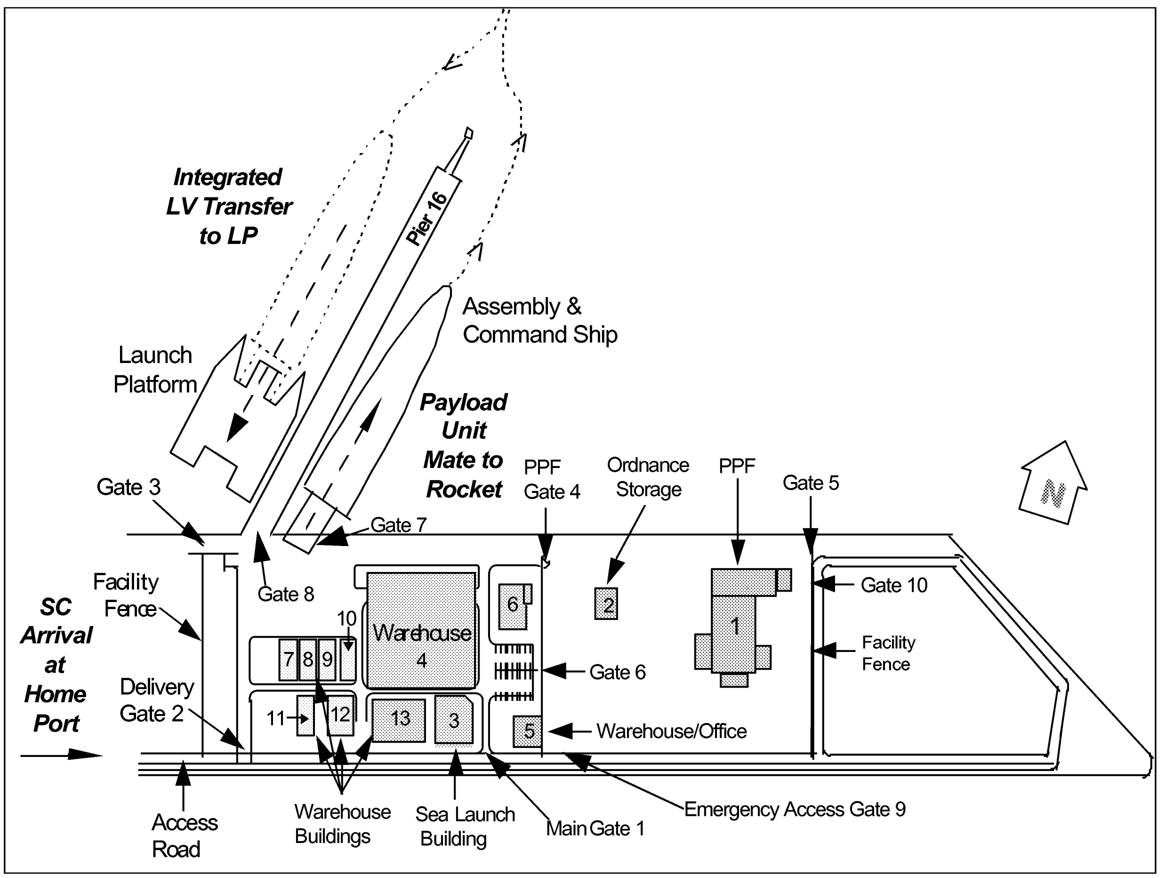

Figure A.4-1. Sea Launch Home Port Complex

The Home Port complex will consist of a payload processing facility (PPF), Sea Launch and customer office facilities, several warehouse buildings, and a pier. The complex is bounded by the access road to the south and the harbor to the north. A security fence encloses the property with access through three gates in the south side fence. The main entrance is through Gate 1, which is staffed 24-hours, seven days a week. Gates 2 and 3 allow oversize truck access to the pier and PPF respectively, and are normally locked. An interior fence separates the PPF area from the rest of the complex, and access to this area is controlled through Gate 4. Two additional emergency access gates, Gate 5 and Gate 6, are located at the northeast and northwest corners of the facility.

Water, sewage, and gas service will be provided to the site by local utility companies. Commercial electrical power will be supplied by Southern California Edison. This power will be distributed through transformers, panel boards, and circuit breakers to all areas within the complex. Emergency power for the PPF will be provided through a 500 kW backup generator with an automatic switching system. To provide further limited protection during test periods, an uninterruptible power supply (UPS) will be available in the processing area.

Industrial waste generated during program procession will be processed in accordance with existing state and federal regulations.

A.4.1 Spacecraft Processing Operations

After delivery to the Home Port, electrical and mechanical checkout of the spacecraft will be conducted in the PPF. After stand-alone testing, the spacecraft will be placed on a customer-provided fueling stand. The customer will be required to perform all required ordnance installation operations prior to fueling. (Please see Appendix B-20 for further details regarding ordnance.) Initial mass properties can be determined at this time. After the customer's fueling team propellant loading operations are complete, final mass properties determinations will be conducted.

While the customer conducts spacecraft ordnance and fueling operations, Sea Launch personnel will transfer the payload fairing and adapter from storage to the PPF encapsulation cell and prepare them for installation. When spacecraft processing is complete, the spacecraft will be transferred to the encapsulation cell and mounted vertically on the flight adapter. The adapter and spacecraft will then be rotated to a horizontal position to accommodate the installation of the payload fairing. Communication checks will be conducted on the spacecraft. Conditioned air flow will be initiated and the payload unit (consisting of the spacecraft, adapter, fairing, and upper stage interface skirt) will be transported to the ACS as a single unit. Spacecraft and equipment environments will be monitored throughout the entire process.

Once onboard the ACS, the payload unit will be mechanically and electrically mated to the previously assembled and tested rocket. Integration tests will be performed between the PU and the rocket. Upon the completion of testing, the integrated launch vehicle (ILV) will be transferred onto the LP and stowed in the LP hangar. The ACS and the LP will then depart for the launch location.

A.4.2 Payload Processing Facility

The PPF (Figure A.4.2-1) is located in Building 1 on the east side of the Home Port complex (Figure A.4-1). In support of the trend in the industry towards "ship and shoot" spacecraft processing operations, this facility will provide common cells for the conduct of both non-hazardous and hazardous spacecraft operations. All spacecraft processing, propellant transfer operations, pressurization, ordnance preparation, and payload fairing encapsulation operations will be accomplished in the PPF. This area will be separated from the rest of the complex by an interior fence with controlled access through Gate 4 during hazardous spacecraft operations.

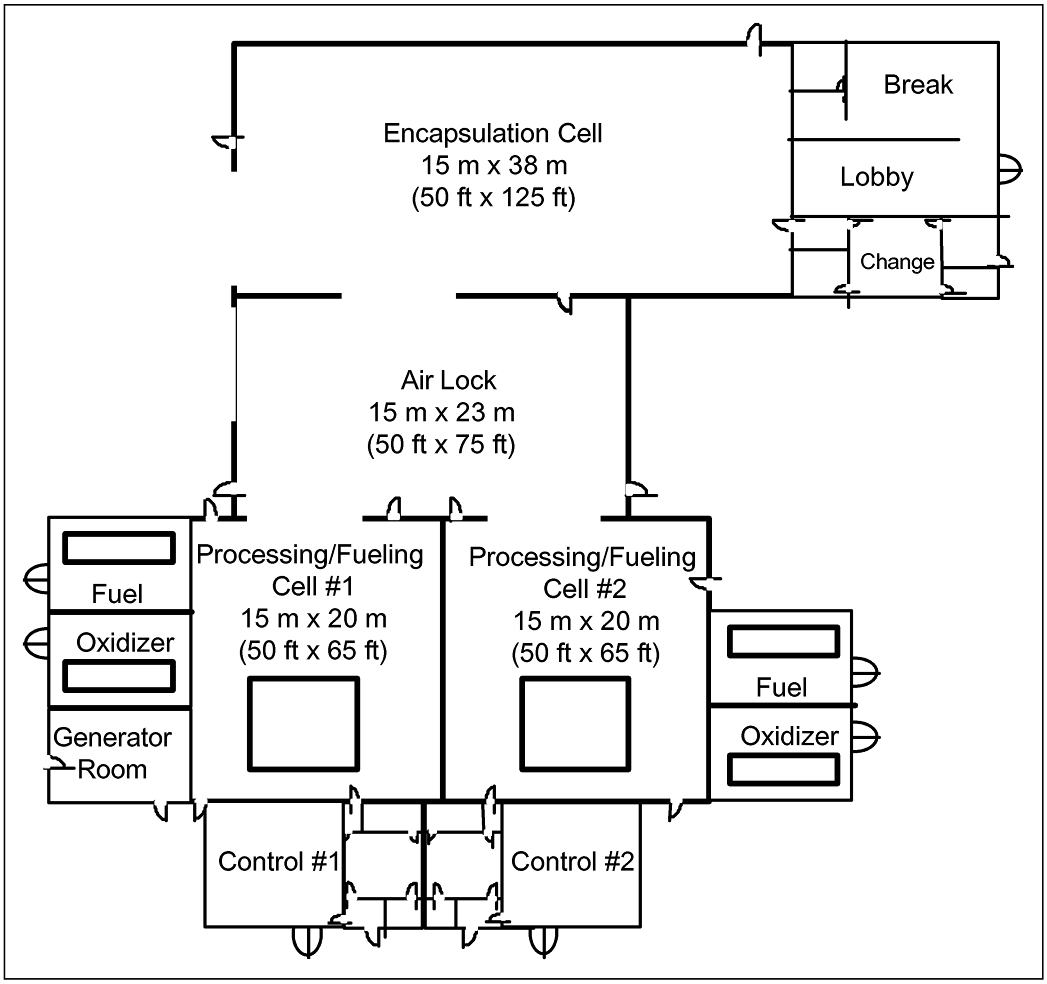

Figure A.4.2-1. Payload Processing Facility

Building 1 will have an overall area of approximately 3,900 m^2, and its major features will include:

1. Processing/fueling cells.
2. Fuel storage rooms.
3. Oxidizer storage rooms.
4. Encapsulation cell.
5. Common air lock.
6. Control rooms.
7. Garment change rooms.
8. Lobby/break area.
9. Generator room.

The processing/fueling cells, encapsulation cell, and air lock are cleanrooms will be maintained to Federal Standard 209 Class 100,000 cleanliness standards. Air filtration will be provided by pre-filters and high efficiency particulate air (HEPA) final filters. To facilitate cleanliness control, the interior wall surface of these areas will be enamel-coated gypsum board and the ceiling surfaces will be vinyl-faced gypsum panels. The floor coverings will be electrically static dissipative and will be compatible with either wheeled dollies or air bearing pallets. Temperature in the air lock, processing/fueling cells, and encapsulation cell will be maintained to 21°C $\pm$3°C. Relative humidity will be maintained between 35%

and 60%. Card readers on personnel doors to high bays and control rooms will provide for controlled access.

A.4.2.1 Processing/Fueling Cells

The PPF will provide two separate, high bay processing/fueling cells configured to support spacecraft processing operations. In order to support spacecraft fueling operations, each cell is equipped with a 7.6 m by 7.6 m fueling island in its center. This island will be surrounded by a covered trench which will drain to one of two dedicated 18,192 L fiberglass, reinforced polypropylene tanks for emergency spill containment. To maintain cleanroom standards, access to each high bay will be controlled via a garment change room. Each processing/fueling cell will be equipped with the following features:

1. Work areas of approximately 300 m^2.
2. Motorized steel rollup access door with manual chain drive backup mechanism. Clear opening measuring 6.1 m by 12.3 m.
3. Personnel access from the air lock through a steel personnel door or from the garment change room through an air shower.
4. Emergency exit only personnel doors along outside walls.
5. Overhead traveling crane with capacity of 13,600 kg with maximum hook height of 15 m.
6. Breathing air system and protective garments for fueling crews.
7. Gas monitoring/detection system for spacecraft fuels.
8. Power receptacles.
9. Potable water hose bibbcock.
10. Vacuum ports with quick disconnect connectors and vacuum line.
11. Closed-circuit television cameras.
12. Wall-mounted telephone.

The two processing and fueling areas will have heating, ventilation, and air-conditioning systems that will provide these areas with an adequate ventilation rating. These areas will be classified Class I, Division 2, up to 3 m above the finished floor. Pits or trenches in the floor will be classified as Class I, Division 2. The areas above 3 m will not be classified in regard to electrical hazard grouping.

Operating personnel will be advised of potential safety concerns through the use of the processing facility public address system, a warning beacon system located on the exterior of the building, and a fire detection and alarm system. The warning beacon system will provide green, amber, and red beacons. The green beacon will be illuminated whenever the building is in a normal state with no fueling operations in progress. Manual switches will activate the amber beacon whenever a potentially hazardous operation is taking place. The red beacon will be activated by the toxic gas monitoring system.

Two single point toxic gas monitors will be provided in the processing, air lock and encapsulation areas, and one single point toxic gas monitor will be provided in each fuel staging cart room. The monitors are capable of monitoring for both components: nitrogen tetroxide (N_2O_4) and monomethylhydrazine (MMH). The alarms will be sounded locally and will also activate the red warning beacon on the exterior of the building. Two alarm set points will be provided; the lower will be set at 75% of the toxic limit, and the higher will be set at 25% of the lower explosive limit (LEL) which will activate the ventilation system purge system for the area. Remote alarm indication will be provided in the main office building.

The payload processing facility fire suppression system will be a dry pre-action system. This system will have compressed air in the lines, maintaining a “dry pipe” condition. The system will be activated by two independent but necessary actions: a smoke/heat detection alarm signal from any of the mounted detectors or from a manual pull station; and an intense heat source sufficient to melt a fusible link in the sprinkler head. The first alarm system action will open a valve which charges the system with water. A high intensity heat source must then be present to melt the fusible plug. This system will provide some protection from water damage to high value hardware in case of a false alarm.

The facility will contain a ground loop system consisting of ground rods and bare copper cable installed around the building. The loop will be tied to every other perimeter building column. A ground buss will be provided in each propellant cart area, each control room, and in the processing and encapsulation areas. Lightning protection per NFPA-78 will be provided.

Access to the facility will be limited to authorized personnel and is controlled by a card reading access control system. The access control system will be a part of the Security Information Management System.

A.4.2.1.1 Propellant Cart Storage Rooms

Two propellant cart storage rooms for each processing and fueling cell will be provided for temporary storage of fuel (N_2H_4 or MMH) and oxidizer (N_2O_4) carts and associated ground support equipment (GSE). The rooms will have an approximate floor area of 37 m^2 with a clear vertical height of approximately 2.7 m and steel access doors measuring 2.4 m by 2.4 m. Emergency drains to the respective fuel and oxidizer containment tanks (18,168 L) will be provided in each room as well as a gas monitoring/detection system for spacecraft fuels.

A wet scrubber system will be provided for the processing fumes that may be released during the fueling operation or in case of an accident. One scrubber will be provided which can be connected to either containment tank via the vent piping system.

A.4.2.1.2 Propellant Carts/Tanks

Propellants will be delivered from the vendors in tanks approved by the U.S. Department of Transportation (DoT) in accordance with Code of Federal Regulations (CFR) 49, Transportation. Tanks planned for use are DoT 110A500W tanks (maximum 908 L capacity) or DoT 4BW tanks (maximum 454 L capacity). Both types of transport/storage tanks will be used for the direct transfer of propellants into the spacecraft by way of a closed-loop system.

A.4.2.1.3 Summary of Propellant Operating Procedures

The amount of propellant to be loaded will be a function of the spacecraft’s weight, its mission, and altitude. The satellites that will be processed through the payload fueling facility will have a mass ranging from 1,500 kg to 3,500 kg. The propellant weight fraction will be between 50% and 70% of the overall payload mass.

Liquid propellant, N_2O_4 and MMH, will be received and staged (temporary storage) in DoT approved containers (i.e., in accordance with CFR 49). The typical container contains 908 liters of liquid propellant. The propellants will be stored in separate rooms until they are needed to fuel the spacecraft. The normal load for a spacecraft requires the transfer of propellant from one tank for each fuel component. Normal practice is to have a second tank of each fuel component available as a backup.

When the spacecraft is fueled, one tank of fuel will be moved into the processing cell at a time. Following transfer of that fuel component into the spacecraft tanks, the processing cell will be cleared of all traces of that component prior to handling the next tank. This will maintain complete separation of the two components at all times.

Although the facility will have two processing cells, only one spacecraft will be fueled at any given time. Even in the instances where the operation requires the preparation of two spacecraft for a dual payload launch, the spacecraft will not be fueled simultaneously. Once fueled, the spacecraft will be moved into a separate cell for encapsulation in the payload unit.

A.4.2.2 Encapsulation Cell

An encapsulation cell will be provided in the PPF for the preparation of payload fairings and adapters, payload mating, and encapsulation. To maintain cleanroom standards, access to the encapsulation cell wil be controlled via the garment change room and the air lock.

A.4.2.3 Air Lock

An air lock will be located between the encapsulation cell and the payload processing and fueling cells. This air lock will provide an isolated area to establish required cleanliness levels for new equipment arriving prior to being moved into one of the clean processing areas and will allow movement between clean areas.

A.4.2.4 Control Rooms

A control room for contractor GSE will be located adjacent to each processing/fueling cell.

A.4.2.5 Garment Change Rooms

The garment change rooms associated with each processing/fueling cell will provide an area for personnel to don cleanroom garments and fueling suits prior to entering the cells. Each room will have a floor area of approximately 27.9 m^2 and will contain personnel lockers, garment racks, fueling suit storage, cleanroom supply storage, a rest room, and benches. An air shower and a rotary brush shoe cleaner will be located at the entrance to each processing/fueling cell.

A.4.3 Solid Rocket Motor Storage

The ordnance storage in Building 2 (Figure A.4-1) will be located on the east side of the Home Port complex. (Please see Appendix B-20 for information regarding ordnance.) This building will provide storage for 24 Zenit separation motors and one spacecraft motor. Solid rocket stages include the solid propellant separation motors of the Zenit stages and a solid propellant stage that may be included in some spacecraft.

The solid rocket motor storage building will be a single story, concrete masonry structure with a steel joist roof framing system. Beyond the usual loads required for any building, this facility must also meet the design requirements for the storage of solid propellants prescribed by the Department of

Defense (DoD 6055.9 STD), the Uniform Building Code, and the Uniform Fire Code. The motors to be stored in this facility are classified Hazardous Division 1.3 or mass fire hazard. A mass fire hazard is one in which the item will burn vigorously with little or no possibility of extinguishing the fire in storage situations. Explosions will normally be confined to pressure ruptures of containers and will not produce propagating shock waves or damaging blast over pressures beyond the quantity distance (Q-D) requirements prescribed in DoD (6055.9 STD) and by the Chemical Propulsion Information Agency (CPIA). The building will not be designed as an explosive resistant structure since the primary hazard is mass fire, not an explosion.

A.4.4 Quantity Distance for Home Port Facilities

The determination of Q-D requirements for safe and segregated storage and handling of spacecraft propellants is based on proposed operations and on criteria established by various governmental agencies. The proposed operating procedures used in the analysis are based on the procedures currently used at other U.S. commercial spacecraft processing facilities. The criteria used to determine Q-D requirements are contained mostly in U.S. Department of Defense (DOD) publications, but also include criteria contained in a joint agency document developed by CPIA. The criteria in these manuals was applied to assumptions made by using the procedures currently employed by the spacecraft industry. This resulted in establishing of a Q-D of 94.5 m for inhabited buildings and 56.7 m for public traffic routes. For solid propellant stage separation motors stored on site, the required Q-D is 29.3 m for both inhabited buildings and public traffic routes.

Q-D reference documents:

CPIA Publication 394 - “Hazards of Chemical Rockets and Propellants, Volume 1, Safety, Health, and Environment.”

DoD 6055.9 STD - “DOD Ammunition and Explosives Safety Standard,” dated October 1992.

Establishes storage compatibility groups (SCG) for explosives. These SCGs are used to keep incompatible materials away from each other during storage. Nitrogen Tetroxide (N_2O_4) is a hazard group I (fire hazard); SCG A (initiating explosive) and monomethylhydrazine (MMH) is a hazard group III (fragment hazard); and SCG C (items that upon ignition will explode or detonate).

TM 5-1300 - “Structures to Resist the Effects of Accidental Explosions,” dated November 28, 1990. NAVFAC P-397, AFR88-2.

A.4.5 Warehouse and Storage Facilities

The high bay area in Building 4 (Figure A.4-1) will be used for storage of inert launch vehicle stages and payload fairings.

Building 5 is a small warehouse/office building that will be used to house a small machine shop and contains offices for Sea Launch resident technicians.

Buildings 7, 8, 9, and 10 offer approximately 1,486 m^2 of storage for customer supplies, equipment, and shipping containers. They are constructed of corrugated steel walls and ceilings with slab on grade floors. Each building is approximately 12 m by 30 m with a vertical height of 6.1 m.

Access for equipment is through a single door in the end of each building measuring 2.4 m by 3 m. A single steel personnel access door is located on the end of each building measuring 0.9 m by 2 m. The storage buildings do not contain overhead cranes. Equipment loading is accomplished by either forklifts or wheeled dollies.

Buildings 11, 12, and 13 will be used for the storage of Sea Launch equipment and supplies. With prior coordination, additional customer storage may be arranged in these facilities if necessary.

A.4.6 Home Port Administrative Facility

The Sea Launch office in Building 3 (Figure A.4-1) will provide facilities for the resident Home Port administrative and professional staff and customers. It is a two-story structure with an area of approximately 2,230 m^2. It will consist of a marketing area, a training area, offices, conference rooms, and a break area.

A.4.7 Pier Facilities and Fueling Services

The pier provides facilities for moorage, servicing, and resupply of the Sea Launch vessels. It has a concrete surface over pilings and is approximately 335 m by 18.3 m. It has provisions for electrical power, communications, water, and sewer services to the vessels while in port. It will also have equipment for loading fuels, compressed gasses, and cryogens. Mooring provisions will allow securing the vessels to both sides of the pier for rocket integration and vessel provisioning operations. The vessels can also be secured in tandem on the west side of the pier for transfer of the integrated rocket from the ACS to the LP. Encapsulated payloads will be loaded onto the ACS using the stern ramp.

Kerosene and liquid oxygen are the primary propellants for Stage 1 and Stage 2 of the Zenit rocket and the Block DM-SL upper stage. The only primary propellant fuel loaded onto the launch vehicle prior to leaving the Home Port will be a small quantity of kerosene on the Block DM-SL upper stage. The remainder of the kerosene and all the liquid oxygen will be carried in bulk storage tanks on the LP and transferred to the ILV at the launch location.

Liquid oxygen, liquid nitrogen, and pressurized gaseous helium will be commercially procured for delivery to the Home Port pier in the supplier's mobile equipment. This equipment is designed to meet the applicable requirements for highway transport set by DOT standards in CFR 49. To support their mobile equipment, the supplier may also provide generic equipment that meets appropriate standards.

The following approximate quantity of material will be required for each launch cycle:

Oxygen -	500 metric tonnes
Nitrogen -	240 metric tonnes
Helium -	1 metric tonne
Kerosene (RP-1) -	120 metric tonnes

A.5 ROCKET LAUNCH AND TRACKING OPERATIONS

A.5.1 Zenit Stage 1 and Stage 2 Operations

Zenit first and second stage flight operations are completely automatic. For a typical GTO mission, duration of Stage 1 flight is approximately 2 min and 30 sec, while Stage 2 separates at about 8 min and 41 sec into the mission. A flight event timeline is included in table A.5.1-1.

Table A.5.1-1. Typical Mission Event Times - GTO Mission

Time (min:sec)	Event
00:00	Liftoff
00:08	Begin pitch hover
01:04	Maximum dynamic pressure
01:49	Stage 1 begin gradual throttle to 75%
02:09	Stage 1 begin throttle to 50%
02:21	Stage 2 vernier engine ignition
02:23	Stage 1 shutdown command
02:26	Stage 1 separation
02:31	Stage 2 main engine ignition
03:37	Payload fairing jettison
07:09	Stage 2 begin main engine gradual throttle to 85%
07:29	Stage 2 main engine shutdown command
08:44	Stage 2 vernier engine shutdown
08:44	Stage 2 separation
08:49	Block DM-SL middle adapter jettison
08:54	Block DM-SL ignition #1
12:46	Block DM-SL shutdown #1 / LEO park orbit
42:46	Block DM-SL ignition #2
49:02	Block DM-SL shutdown #2/ GTO
49:17	Spacecraft separation

All Stage 1 and Stage 2 events will occur within the view of either the ACS or the Selena-M tracking ship. The spent stages will fall in the Pacific Ocean, well short of the coast of South America and the major coastal shipping lanes. Any deviation of flight trajectory from preprogrammed limits will cause onboard systems to automatically terminate propulsion and end the mission. This approach to flight safety obviates the need for the traditional range safety officer with a finger on the destruct button.

At second stage separation from the Block DM-SL, four solid propellant rocket motors at the base of Stage 2 will fire to back the stage away from the Block DM-SL. The pause between Stage 2 shutdown and Block DM-SL first firing will be approximately 10 sec. Half way through this period, the Block DM-SL middle adapter will be jettisoned.

Following Stage 1 engine ignition and liftoff, the aerodynamic loads will be minimized by flying with a near zero angle of attack through the high dynamic pressure (Q) regime. A maximum Q of 5300 kgf/m^2 will occur 65 sec after liftoff. A maximum axial acceleration of four g's will occur at 110 sec. At this point the engine will gradually throttle to 75% over a period of 20 sec and then immediately will throttle to 50%, which it will hold until the engine shutdown command at 143 sec. Stage 1 separation will occur at 145 sec.

The Stage 2 engine will ignite slightly before the Stage 1 engine shutdown command, and the main engine will ignite five seconds after separation. To satisfy spacecraft thermal requirements, the payload fairing will be jettisoned at about 220 sec. At 430 sec, the main engine will gradually throttle to 85% over a period of 20 sec. This will be immediately followed by an engine shutdown command at 450 sec. The vernier engines will continue burning for an additional 75 sec, at which time they will shutdown and Stage 2 separation will occur.

A.5.2 Block DM-SL (Upper Stage) Operations

Prior to launch, the Block DM-SL onboard systems will be turned on and initialized, its oxidizer will be loaded, and power will be transferred from the LP umbilical to the Block DM-SL internal power supply. During Stage 1 and 2 flight phases, the Block DM-SL will remain inactive, except for preparations for autonomous flight. Upon reaching the interim orbit, the Block DM-SL will separate from the launch vehicle. Final insertion to a low earth orbit (LEO) park orbit will be achieved with a single main engine burn at the interim orbit apogee with no change in inclination. Prior to each subsequent main engine firing, the Block DM-SL will perform a settling burn using the attitude control system. Burn program options include, but are not limited to, two- or three-impulse insertion of the spacecraft directly into geosynchronous orbit (GEO), one- or two-impulse insertion into geosynchronous transfer orbit (GTO), and multiple burns (up to a maximum of seven) to medium earth orbit (MEO) or planetary escape. Launches from the equator will take up to eight hours to reach geosynchronous orbit.

Block DM-SL ignition will occur 10 sec after Stage 2 separation. Immediately after separation, the Block DM-SL middle adapter will be jettisoned. The Block DM-SL engine will burn for 230 sec to establish an intermediate LEO park orbit. After a 30 min or more coast in this park orbit, the engine will restart and burn for an additional 375 sec to inject into GTO. The 30 min coast will allow for sufficient engine thermal conditioning at the time of restart, and applies to all Block DM-SL restarts.

The LEO park orbit, combined with the equatorial launch location, may be used to deliver a spacecraft to any GTO apogee longitude in a relatively short period of time. Alternatively, the park orbit may be eliminated so that the Block DM-SL directly injects into GTO with a single 605 sec burn. This option cannot be used to deliver directly to any longitude, but it does complete the mission quickly without a coast phase or engine restart.

The Block DM-SL is capable of performing seven engine restarts and can handle a variety of missions and injection strategies. For example, intermediate and high earth orbit satellites may be delivered to either a transfer orbit or the final orbit. Additionally, the Block DM-SL has the capability to perform the phasing to the final desired location in that orbit. During the intermediate coast phases, the Block DM-SL can accommodate sun-angle pointing and continuous thermal rolls.

Tracking and telemetry return will be provided by the ACS, Altair communication satellites, existing Russian-controlled ground stations, and TDRS. During passive flight phases, specific attitude control maneuvers (i.e., a thermal roll) may be conducted by using the attitude control/ullage propulsion engine to meet spacecraft requirements.

Optional functions include establishment of a spin rate of up to 30 rpm prior to spacecraft separation and establishment of a specific orientation at separation. The spacecraft target orbit parameters will be determined and insertion accuracy will be verified for the moment of separation.

Following spacecraft insertion to the target orbit, the Block DM-SL will separate from the spacecraft and perform a contamination and collision avoidance maneuver (CCAM). Disposal options include transfer of the Block DM-SL to a higher or lower disposal orbit or establishment of a low enough orbit to ensure re-entry. The final operation of the Block DM-SL will be to vent all volatile liquids and gasses to prevent explosive destruction.

A.5.3 Range Tracking Assets

The current Sea Launch baseline range tracking assets will be centered on the ACS. Other tracking assets include: a satellite system called Altair (also called Luch or Lutch); ground tracking stations in and around Russia, including the Moscow Center; and TDRS. Other assets continue to be considered. For example, western tracking satellites and mobile tracking stations; however, these assets are not currently part of the baseline. The following paragraphs (Sections A.5.4 to A.5.7) apply to launch vehicle telemetry reception and routing. Payload unit and satellite telemetry handling baseline have not yet finalized.

During the ascent, the Zenit-3SL will be tracked by a combination of ships and satellites. For the first 410 sec the trajectory will be visible to the ACS, which is located five km from the launch platform. Throughout the remainder of the ascent to LEO park orbit, the trajectory will be tracked by TDRS. The Russian Altair tracking and data relay satellite system will provide additional coverage for subsequent Block DM-SL burns.

A.5.4 Assembly and Command Ship

The launch sequence/countdown for the integrated launch vehicle (ILV) will begin several hours before launch and will be controlled remotely from the ACS. After the launch the ACS receives telemetry from the LV until the LV is acquired by downrange assets.

A.5.5 Tracking Downrange System

Launch vehicle telemetry will be received by TDRS. This telemetry will be collected and re-transmitted via communication satellites to the mission control center (MCC) on the ACS and to the Moscow Center.

A.5.6 Satellite Tracking System

After orbital insertion, the Block DM-SL will continue to broadcast telemetry to the Altair satellite system. When the Block DM-SL is within line-of-sight of an Altair, it will broadcast telemetry to the Altair which will relay the telemetry (via communication satellites and ground stations) to the ACS and to the Moscow Center. When the Block DM-SL is not within line-of-sight of an Altair, it will store the telemetry and transmit the data after it comes within view.

A.5.7 Launch Location

Since the Zenit-3SL is launched from a mobile, sea-based launch platform, there is some flexibility in the location of the launch. However, considerations such as stage impact points, weather, and LP transit times restrict the vehicle from being launched at any location. Figure A.5.7-1 identifies the launch region in the Pacific Ocean. All data in this section assume an equatorial launch location with coordinates 0^0 N, 154^0 W. This is approximately 10 days LP sailing time from the Home Port, and less than one day ACS sailing time from Kiritimati (Christmas) Island.

A.5.8 Ascent Trajectory

The Zenit-3SL ascent trajectory will be tailored to optimize the mission's critical performance parameters while satisfying spacecraft and launch vehicle constraints. This section gives an overview of the ascent trajectory and flight profile.

Table A.5.1-1 (Section A.5.1) and Figures A.5.8-1 through A.5.8-3 illustrate a typical Zenit-3SL ascent trajectory for a GTO mission. Table A.5.1-1 is a listing of the times at which the main mission events occur, and Figure A.5.8-1 shows the ascent groundtrack and illustrates the tracking coverage. Figures A.5.8-2 and A.5.8-3 show the flight profile to GTO, with key events and parameters labeled.

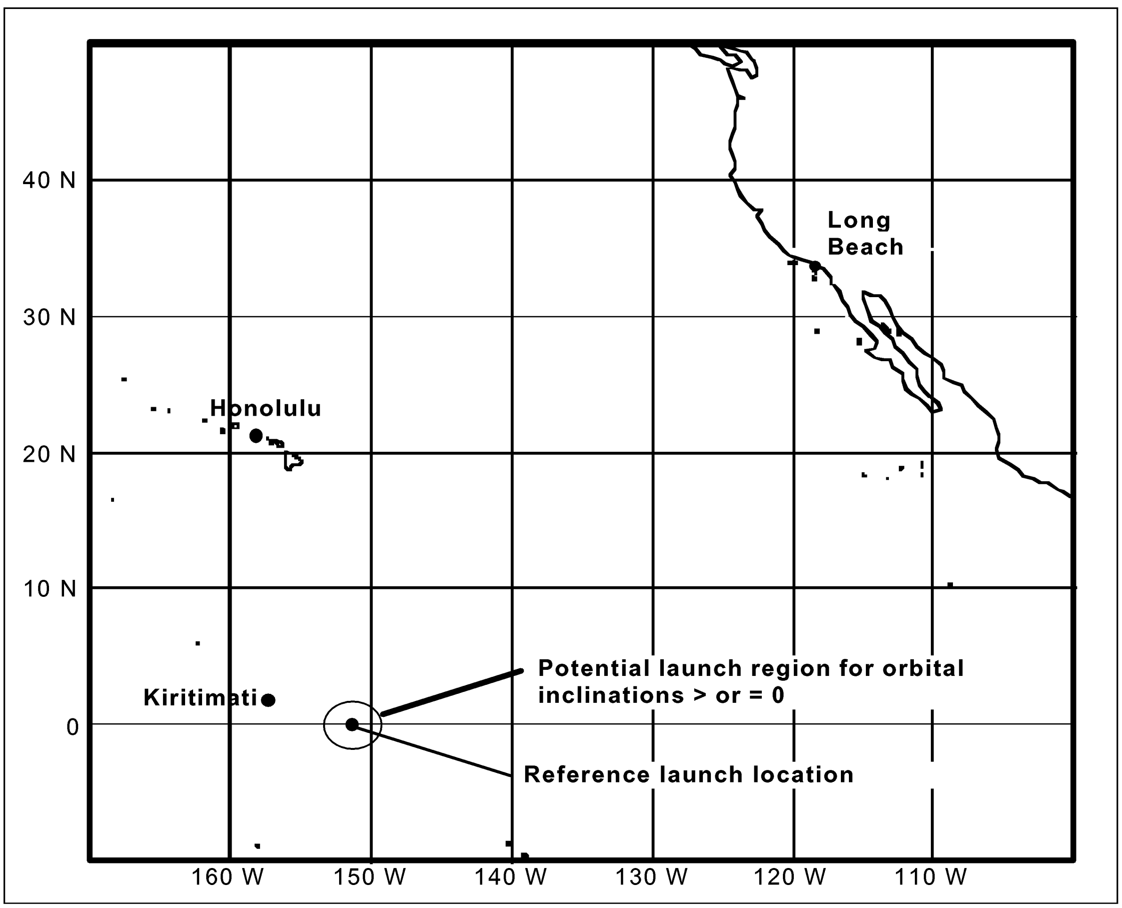

Figure A.5.7-1. Potential Launch Region

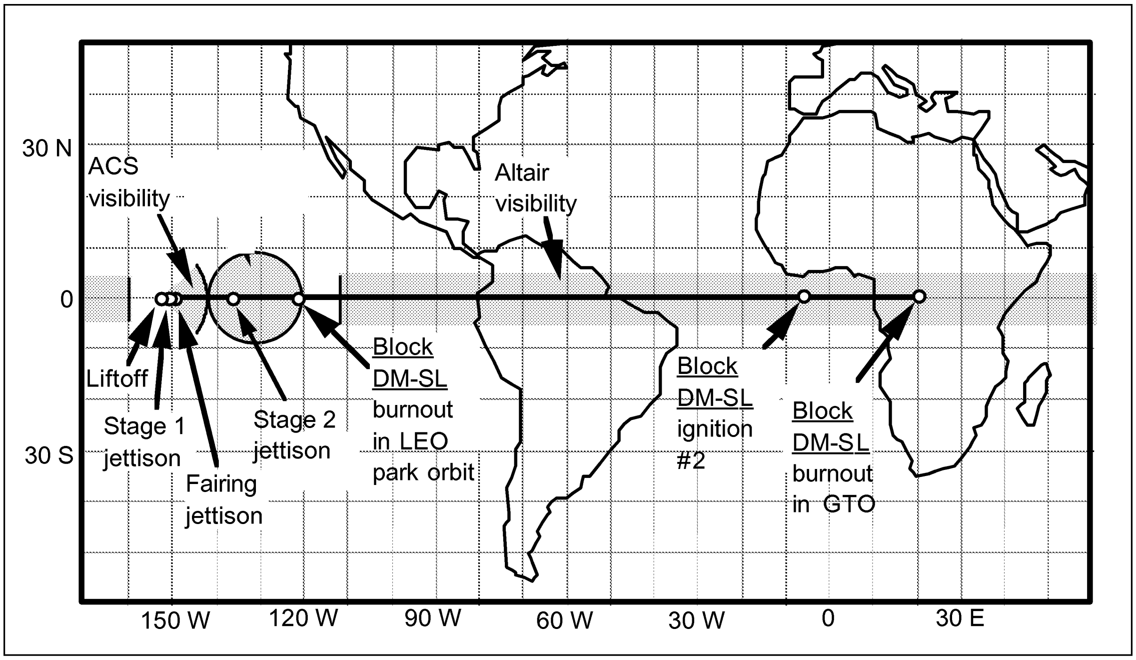

Figure A.5.8-1. Typical Flight Profile - GTO Mission

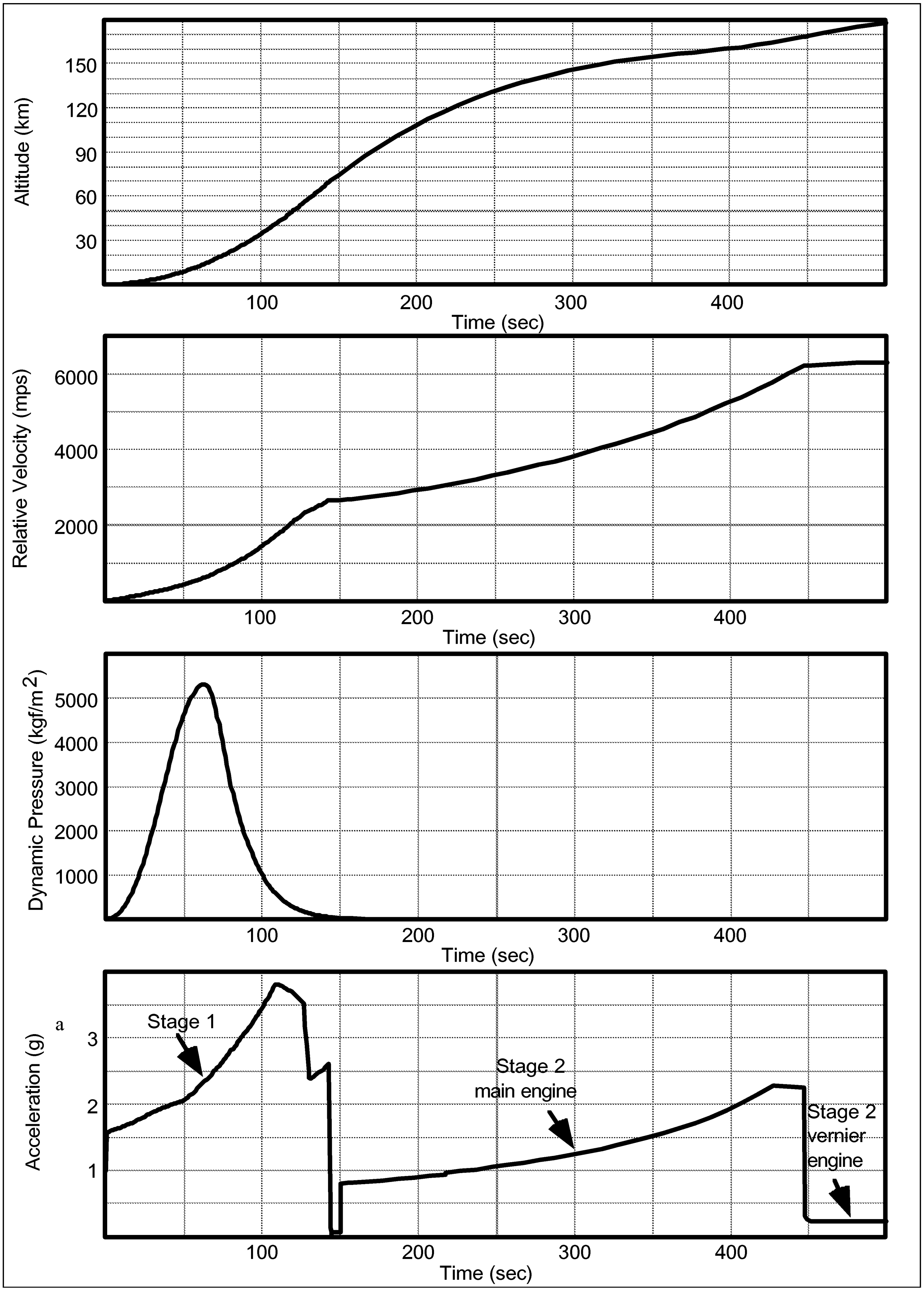

Figure A.5.8-2. Typical GTO Trajectory Parameters - Stage 1 and Stage 2

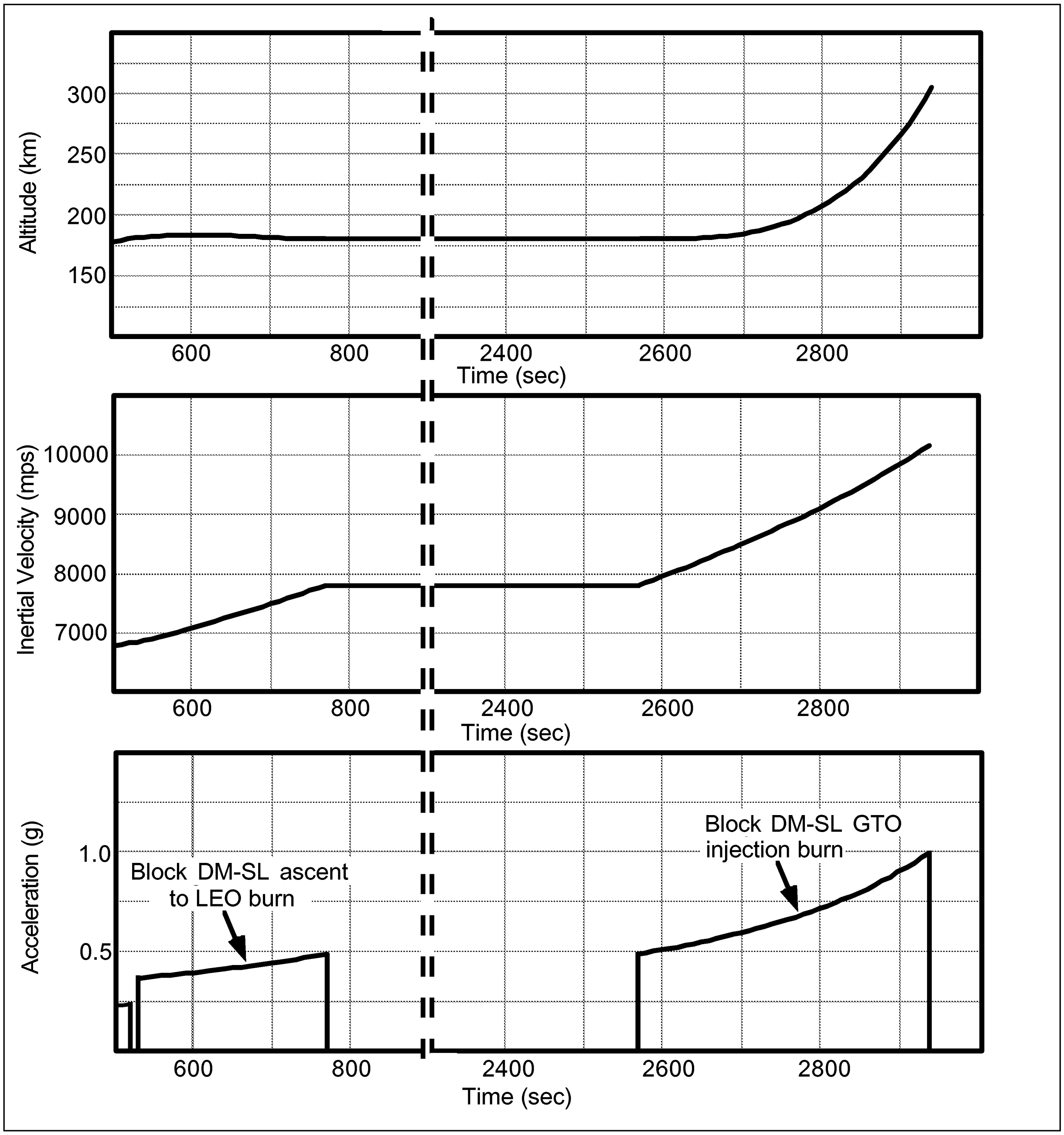

Figure A.5.8-3. Typical GTO Trajectory Parameters - Block DM-SL

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